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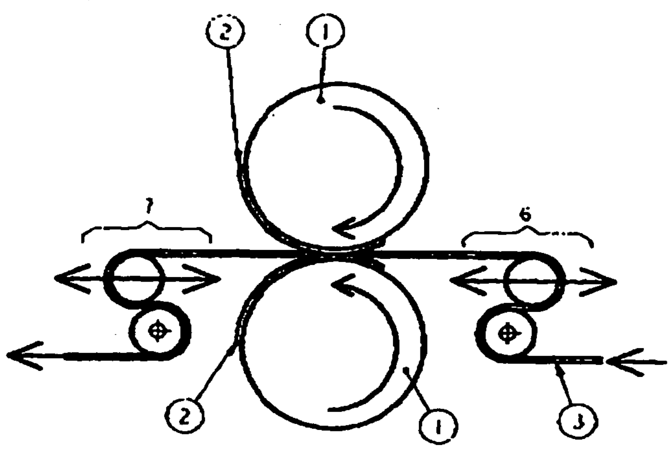
(54) Injector for rotary web processing device with fixed diameter base

(57) A unique rotary die cutting system including an injector mechanism (6) that accurately positions a moving continuous web (3) in such manner as to permit the implementation of a set of constant diameter cylindrical bases (1) onto which are mounted by various means a pair of removable complementary steel sheet dies (2). The integrated action of the novel sub-sections of the invention permits significant improvements in economies of operation relative to exiting rotary converting technologies.

FIXED DIAMETER BASE ROTARY DIE CUTTER
(BASE REPEAT "3X")



PRINT/DIE REPEAT "X"

FIGURE 2A

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Description

[0001] This invention relates to an unique, intermittently fed, rotary converting method and apparatus by which web-fed carton board material is converted into die cut and creased parts. The same process has numerous potential applications in other industries where rotary converting of a web substrate is used, such as the pressure sensitive label business.

[0002] In the canon board industry, the conversion of raw board stock (sheet or web form) into finished cartons ready for filling consists of three basic sequential processes, namely; printing, cutting/creasing, and folding/gluing. These processes arc typically carried out independently from one another with intermediate storage being required, although in some cases printing and cutting/creasing may be carried our in-line with one another. In the industry there are two basic methods used to cut and crease a printed board substrate into finished shape flat parts, one being flat die cutting, the other, rotary die cutting. Both of these processes and their related art have been well documented in numerous patents and industrial literature. Typically, board material that has been printed in sheet form is subsequently die cut in a flat die cutter located off-line from the printing press. Board material that is printed in continuous web form can be subsequently creased and die cut in-line with the press with either a flat or rotary die cutting mechanism. For web-fed applications, selection of the appropriate die cutting method is determined by the economics of the total conversion process of the print job(s) being run. Factors influencing the selection of the cutting/creasing method include: capital cost of the cutter mechanism, rooting cost, substrate thickness, tool life, change-over/make-ready time, process speed, length of the job run and toot supply lead time. Each process has distinct advantages relative to the other; however, only a careful analysis of these various parameters relative to a specific print business mix can determine the best cutting method to be used. While it is possible to have both processes in-line with one printing press, this is typically not done due to the high capital cost and/or high tooling cost of such a scheme. Generally speaking, the advantages of flat cutting/creasing relative to its rotary alternative are:

i) lower creasing/cutting tool cost,
ii) shorter tool supply lead time.
iii) can process a wider thickness range of substrates,
iv) creasing and cutting with one tool,
v) cheaper to refurbish tool

[0003] The usual advantages of rotary cutting are:

a) higher running speeds,
b) lower capital cost of the cutter mechanism,
c) longer tool life,
d) shorter change-over/make-ready time,
e) can have cutting and creasing in one tool (but more expensive than split function rotary tooling).

[0004] The trade-offs between both methods have typically resulted in fiat die cutting being used for short print runs and rotary die cutting finding application for long print runs. What has perplexed the board industry is that while print run lengths are trending down due to just-in-time requirements, the industry would like to be able to realize the advantages of rotary cutting, namely; lower capital cost, higher run speeds and shorter job change-over times. The main deterrents to this realization are tool cost and supply lead-time.

[0005] A significant recent development that reduces some of the cost obstacles to the use of rotary tooling is the adaptation of flexible steel die technology to carton board cutting. State-of-the-art rotary dies are typically steel cylinders with cutting and creasing patterns chemically etched or machined onto their circumferential surfaces. These relief patterns are an integral feature of the cylinder. Through use the edges of the patterns wear and must be re-machined. This can typically be done up to 5 times, after which the entire root must be scrapped. The refurbishing of the rotary tool is expensive, typically costing 20% of the original tool cost and involves significant lead-times. This is in addition to the high original cost of the rotary tool itself. Rotary cutting tools are supplied in marched male/female sets, most often with the creasing performed in one set with the die cutting done in a second set. Cutting and creasing can be done in one tool set, but only at increased cost relative to the split set arrangement. Either way, cost is high and lead times are long relative to flat die cutting tools.

[0006] The rotary sheet die format makes use of thin steel sheets (up to 0.040" thick) that are chemically etched or machined and then attached to base cylinders. Thus, the cost of replacement is limited to the sheet die itself, not the expensive base cylinder. The cylinder bases effectively have an infinite life. Means of attachment of the flexible die to the base cylinder can include mechanical locks, adhesive or magnets. The cost of a rotary sheet die is typically three to four times that of a flat die and has a life double that of a flat die. Therefore, the use of flexible sheet dies partially overcomes the cost objections to rotary cooling. As well, sheet die manufacturing and delivery lead-time is approximately 6 days (versus 3 days for flat dies), a significant improvement over solid rotary tool delivery lead-time. What the use of flexible sheet dies does nor resolve is the cost of the various base cylinder sizes required to match the sheet die lengths being used. This constraint results from a very basic feature of most print processes, that is, the fact that the printed images are of a fixed length ('repeat') for each job run. These images are printed from rotary cylinders of fixed repeat (circumferential length). The repeat of the rotary die-cutting tool

must match the repeat of the printed image, since the tool is cutting the profile of the printed image(s). Since many print processes (flexography, letterpress, screen, etc.) offer a wide range of possible repeat sizes, there is no constraint on printers to print all jobs at one repeat. In fact, just the opposite is the case, that is, print image preparation will almost always select a repeat size that economically accommodates the size and shape of the image to be printed. Most flexographic printing machines, for example, allow a wide range of repeat lengths, typically in 1/8th-inch increments. This results in printers having to purchase and maintain a large inventory of print and die cut tooling. In the case of die cutting, each unique repeat used would require a tool of specific length. This is true for both flat and rotary die cutting. Thus, it can be seen that a printer whose business caters to customers requiring a wide range of repeat sizes will often opt for the flat die cutting process, just because of the tool cost.

[0007] The use of rotary flexible dies reduces cost, but does not remove the cost associated with the different-sized cylinder bases required. It is exactly this constraint that the applicant aims to address with the unique process described herein.

[0008] Current state-of-the-art rotary die cutting (integral or flexible) uses rotary tools that have base cylinder repeats that match the repeat lengths of the print. In this manner, there is always an integral (e.g. 1 to 1, 2 to 1, 3 to 1, etc.), match between the rotary tool circumferential length and the print repeat (image) length. A change in print repeat length requires the use of a new rotary tool repeat. The applicant is proposing an unique method whereby flexible steel dies of various repeat lengths can be used in conjunction with two rotary base cylinders of fixed repeat (i.e. diameter). Such a system thus requires the use of only one set of base cylinders (for matching male and female flexible dies), and thus removes the main cost deterrent associated with the use of rotary flexible die cutting.

[0009] Dynamic considerations of the proposed system dictate the use of a base cylinder circumference larger than the longest repeat size to be used. This being the case, there will always be a gap between the leading and trailing edges of the flexible die. Since the web carries a continuous series of successive printed images that are adjacent to each another, it can therefore be seen chat the printed web must be repositioned such that the position of each successive printed image is synchronized with the cutting pattern on the rotary tool, the repeat of which is constant but the image on which is discontinuous. The indexing of the web through the rotary cutting section is such that the web speed matches that of the rotary tool when the web is engaged with the cutting pattern on the tools. Upon disengagement of the web from the nipping action of the rotating die set, there then exists a portion of the cycle during which the web is unengaged in the gap that exists between the leading and wailing edges of the flexible die image. It is during this portion of the cycle that the proposed mechanism is able to reposition the web such that the leading edge of the next printed image to be cut is aligned, both longitudinally and laterally, with the leading edge of the flexible die image. Central to the implementation of this method is the use of an unique injector mechanism that allows the controlled entry of the printed web into the rotary die cutting section. The injector is based upon a mechanism previously patented by the applicant (U.S. 5,762,254).

[0010] The function of the injector is multi-fold:

a) Convert the motion of a continuously moving web (from the print section) into the intermittent motion required for synchronization with a fixed diameter base rotary die cutter.

b) Laterally guide the web into the rotary die cutting section.

c) Serve as a means to smoothly transition the web from an area of high tension (as exists in the print section) to an area of lower tension in the rotary die cutting section. This is critical to the success of the proposed system for two reasons:

i) The smooth transition in tension facilitates the improved control of both longitudinal and lateral print-to-die cut registration. The trapping action of the top and bottom enveloping belts of the injector permits a degree of web control not possible with current technologies such as servo driven nip in-feeds and loop-fed systems (zero tension). Tensioning of webs always results in superior web control.

ii) The arrangement allows for higher accelerations of the web than other existing web positioning systems. This permits the higher rate web repositioning action required for the success of the proposed system, which results in improved production output.

[0011] The injector operates with two types of motion input; rotary for drive to the web, and linear for indexing of the web to produce the position profile necessary for the fixed diameter base rotary cutter. These two motion inputs may variously be by rotary mechanical motion generators, rotary servos or linear electrical servos.

[0012] The fixed diameter rotary die cutter set may be operated at constant angular velocity. For optimum web speed capabilities the die cutter can be operated at a variable speed race such that accelerations of both the web and mechanism are minimized, thus allowing higher operating speeds (approximately 15% faster). In either case, the injector is capable of generating the web motion necessary for synchronized cutting action of the web.

[0013] The proposed system may be configured in several formats, depending on the production goals of

the user. These configurations are explained in the description of the drawings. Of particular interest is the version that allows for the die cutting, creasing and window stripping of the continuous web followed by rewinding of the web into roll form, as opposed to delivery of individual cartons. The rolls of die cut cartons can then be introduced to the final step of the conversion process (gluing/folding) without the handling and storage expense associated with current methods. In addition, handling the parts in roll format permits a condition of optimum security. Cartons need be inspected only once, on the press. Integrity is assured by the roll format.

[0014] The present proposal addresses the aforementioned shortcomings of the rotary die cutting process as follows:

1. It permits running a full range of die repeat lengths with a single base tool repeat. This results in a significant saving in tooling costs.

2. In all embodiments, the web prior to the die cutting section is kept under controlled tension. This permits improved web guiding capability compared to existing in-feed loop or intermittent draw systems.

3. Convertible action: If desired, the proposed constant diameter base die cutter module can be operated as a conventional full wrap repeat die cutter tool, that is, in a one-to-one speed ratio to the print section of the press. A separate tool set, complete with bases, would be required for each specific repeat. In this case, the web injector and out-feed mechanisms are locked in stationary positions, thus permitting the web to pass through the die cutter with constant velocity. In this case, the peripheral tool speed matches the continuous speed of the web in the print section of the press.

4. The action of the injector's enveloping belts permits a smooth transition in web tension as the web passes from the higher tension zone in the print section to the lower tension zone just prior to the rotary cutter. This facilitates print-to-die registration control. Existing rotary die cutter technology typically utilizes a nipped draw roll between the print and rotary die cutter sections of the press. This arrangement results in a tension shock to the web as it passes through the tension differential existing at the nip point. This sharp tension gradient results in web instability, and in turn, registration errors.

5. The repeat range of the fixed diameter base rotary cutter is not dependent on machine width considerations. With standard rotary die cutting, tool deflection considerations have resulted in a rule-of-thumb dictating that the minimum die repeat that can be specified must be at least equal to, preferably greater than, the tool (machine) width. Since a large diameter base is always used with the proposed die cutter, deflection is not a consideration. Thus, there is no theoretical limit to the minimum repeat that may be used (there may be practical dynamic limitations).

6. For the proposed device, the die repeat need not adhere to any series of integral values as specified by standard conventions. Die repeat may be Imperial, metric, or for that matter, any value within the entire repeat range. This permits greater flexibility in responding to marketplace requests.

[0015] In one aspect, this invention provides, for use with a machine through which an elongate web passes with continuous movement, the machine having means for performing a given operation on the web, said given operation lying within a predetermined repeat length, adjacent repeat lengths being separated by repeat length boundaries,
the combination of:

a rotary processing device including two rotary base rollers for positioning downstream of said machine, the rollers being juxtaposed to define a nip through which said web passes, each roller having the same circumference, said circumference exceeding the repeat length of said given operation, the rollers having secured thereto cooperating circumferential processing plates each of which includes a first portion intended to engage the web where rotary processing is carried out, and a second portion which does not engage the web; and drive means for rotating the base rollers;
an injector mechanism adapted for positioning between said machine and said rotary processing device, said injector mechanism being adapted to modify the continuous movement of the web, as it comes from said machine, to a variable movement;
the injector mechanism including:

-- a frame,
-- a carriage mounted on the frame for reciprocating movement with respect to said rotary processing device,
-- first and second idler rollers mounted on the injector frame for free rotation,
-- a third idler roller mounted on said carriage for free rotation, said third idler roller being spaced away from said first and second idler rollers,
-- a driven roller mounted for rotation about an axis which is fixed with respect to the rotary cutter and is located with respect to the third idler roller such that the web, when strung between the first and second idler rollers

thence around the third roller thence around said driven roller, assumes a quasi-boustrophedonic configuration whereby the portion of the web between the third idler roller and the driven roller decreases when the carriage moves in a direction which decreases the distance between the third idler roller and the driven roller;

-- an upper and a lower endless belt passing in juxtaposed relation between said first and second idler rollers, thence around the driven roller, thence around said third idler roller, thence along different respective return paths to said first and second idler rollers;

-- drive means for positively rotating said driven roller at a substantially constant speed;

-- and motion generating means for moving the carriage with respect to said machine, such that the web has a variable motion required to juxtapose the leading edge of each repeat length on the web with the leading edges of said portions of the processing plates intended to engage the web.

[0016] Additionally, this invention provides a method for handling an elongate web proceeding at uniform speed from a process in which it repeatedly undergoes a given operation, said given operation lying within a predetermined repeat length, adjacent repeat lengths being separated by repeat length boundaries,
the method including: providing a rotary processing device including two rotary base rollers for positioning downstream of said process, the rollers being juxtaposed to define a nip through which said web can pass, each roller having the same circumference, said circumference exceeding the repeat length of said given operation, the rollers having secured thereto cooperating circumferential processing plates each of which includes a first portion intended to engage the web and a second portion which does not engage the web; and roller drive means for rotating the base rollers; further providing an injector mechanism adapted for positioning upstream of said rotary processing device and for receiving said web, said injector mechanism being adapted to modify the continuous movement of the web, as it comes from said process, to a variable movement; the injector mechanism including:

-- a frame,

-- a carriage mounted for reciprocating movement with respect to said rotary processing device,

-- first and second idler rollers mounted on the injector frame for free rotation,

-- a third idler roller mounted on said carriage for free rotation, said third idler roller being spaced away from said first and second idler rollers,

-- a driven roller mounted for rotation about an axis which is fixed with respect to the rotary processing device and is located with respect to the third idler roller such that the web, when strung between the first and second idler rollers, thence around said driven roller, thence around the third roller, assumes a quasi-boustrophedonic configuration whereby the portion of the web between the third idler roller and the driven roller decreases when the carriage moves in a direction which decreases the distance between the third idler roller and the driven roller;

--an upper and a lower endless belt passing in juxtaposed relation between said first and second idler rollers, thence around the driven roller, thence around said third idler roller, thence along different respective return paths to said first and second idler rollers;

the method further including:

-- rotating the base rollers of the rotary processing device;

-- rotating said driven roller at a substantially constant speed;

-- passing the web, after it emerges from said process, between the first and second idler rollers such that it is sandwiched between said upper and lower endless belts,

-- moving the carriage with respect to said machine such that the web has a variable motion required to juxtapose the leading edge of each repeat length on the web with the leading edges of said portions of the processing plates intended to engage the web.

GENERAL DESCRIPTION OF THE DRAWINGS

[0017] Several embodiments of this invention are illustrated in the accompanying drawings in which like numerals denote like parts throughout the various views, and in which:

Figures 1A and 1B are schematics of conventional rotary die cutters showing dimensional implications of various repeats;

Figures 2A and 2B are schematics of the proposed fixed diameter base rotary die cutter, again showing dimensional implications of various repeats;

Figure 3 is a schematic side elevational view of the injector section of the proposed mechanism;

Figures 4a to 4f are elevational views showing the web injection sequence relative to die cutter rotation;

Figure 5a is a perspective view of an embodiment which includes an injector, a fixed diameter base

rotary die cutter, a rotary enveloping out-feed, a rotary repeat diameter base pin stripping apparatus, and delivery;

Figure 5b is an elevational view of the arrangement shown in Figure 5a;

Figure 5c is an elevational view of a portion of a assembly, showing delivery into a roll.

Figure 6a is a schematic of an embodiment which includes an injector, a fixed diameter base rotary die cutter, a fixed diameter base rotary pin stripper, and parts delivery.

Figure 6b is an elevanonal view of the arrangement shown in Figure 6a.

Figure 7a is a perspective view of an embodiment with a injector, a fixed diameter base rotary die cutter, a repeat diameter base rotary pin stripper, and parts delivery;

Figure 7b is an elevational view of the arrangement shown in Figure 7a.

DETAILED DESCRIPTION OF THE DRAWINGS

[0018] Figures 1A and 1B each show a schematic axial view of a typical rotary die cutter set. In both cases the rotary cutting/creasing pattern is continuous, there are no gaps. The repeat of the rotary tools matches the print repeat. The Figures differ only in the circumference of the cylinders. The peripheries of the rotary tools move at the same speed as the web substrate, that is, there is a one-to-one speed ratio between the two. Although the rotary cutting/creasing patterns may be integrally formed on the base cylinders, in the case shown, a matching pair of complementary full wrap flexible sheet dies 2 is attached to a pair of base cylinders 1 . The flexible dies and solid bases have the same repeat. Figure 1a depicts the entrance of a continuous web 3 into the rotary die section, which is separated from the prior print section of the printing machine by a rotary nipping arrangement comprised of a draw roll 4 and impinging nip roll 5. This nipping format attempts to isolate the tension zone of the printing section from the lower tension zone existing in the die cutter section. There must be a tension reduction in the web in the die cutter section due to the fact that the web has been partially cut across its transverse direction, thus reducing the cross sectional area of web available to carry the longitudinal tensile load in the web. If the tension in the web was not lowered in the die cutter section, one or both of two events would occur:

a) the web would elongate relative to its state in the print section, thus reducing the degree of fit (i.e. registration) between the printed images and the die cutting tool. This would result in cartons with printed images shifted to one end of the carton, and/or

b) breakage of the web due to the increased tensile load exerted over each unit area of remaining intact web.

Individual parts may be removed from the web immediately after the die cutter, or at a point further along the press. Figure 1a depicts a rotary tool set sized for a print repeat of dimension 'x'. Figure 1b shows the same arrangement, this time sized for a repeat of '2x'. As can be seen, with a conventional rotary die cutter, each time the print repeat is changed it is necessary to change the rotary cutting tool repeat so that the two match.

[0019] Figures 2A and 2B each show a schematic side elevational view of the proposed rotary die cutter with fixed diameter bases. In both cases, the rotary cutting/creasing pattern is contained in a flexible steel sheet and is continuous, however, a gap separates the leading and trailing edges of the pattern. The repeat of the flexible rotary dies 2 matches the print repeat, but the repeat of the rotary base rollers 1 does not. In Figure 2a the print repeat is the same as in Figure 1a, namely, 'x', however, the repeat of the rotary base is a constant, in this case. '3x'. In Figure 2b the print repeat is '2x', but the rotary base repeat remains '3x'. For dynamic reasons, the rotary base repeat will always be longer than the longest print repeat of the press. The peripheries of the rotary tools move at a higher speed than the average speed of the web 3 as it exits the injector mechanism 6. In the instance where the rotary die cutter operates at constant angular velocity, the ratio between the die cutter peripheral speed and the web speed in the print section of the press is proportional to the ratio of the rotary base repeat-to-print repeat. For the example in Figure 2a:

- print section web speed = 200 ft/min (constant)
- print repeat = x
- rotary base repeat = 3x

[0020] Therefore, peripheral speed of the rotary die cutter tool will be

$$= (3x/x)\ (200) = (3)(200) = 600 \text{ ft/min}$$

[0021] In the case shown in Figure 2b, the die cutter peripheral speed would be

$$= (3x/2x)\ (200) = 300 \text{ ft/min}$$

[0022] In the case where the rotary die cutter follows a variable speed profile, the same ratio would apply, but only to the *average* speed of the die cutter. Figures 2a and 2b also show a web indexing mechanism 7, which is an invention previously developed by

the applicant. It is to be noted that the flexible dies used in the Figure 2a and 2b arrangements may have a physical length that is anywhere in the range between the print repeat and the rotary base repeat. What is significant is that the relief pattern on the sheet die that performs the cutting and creasing always equals the print repeat found on the web and is thus always shorter than the base repeat. Non-relief areas along the length the sheet dies are manufactured to a lower elevation so as to allow the existence of a peripheral radial gap between the trailing and leading edges of the cutting/creasing pattern areas.

[0023] Figure 3 is a schematic side elevational view of the injector mechanism 6 that is used with all embodiments of the invention. This mechanism is analogous to the applicant's previous invention as described U.S, patent 5,762,254. The applicant's patent describes a device used to convert a continuous web from intermittent motion to constant motion. The injector 6 is essentially an inversion of this, whereby a continuous web moving at constant speed is manipulated through a defined cycle such that the velocity profile of the web upon exit from the injector 6 enables the web to be positioned to correctly engage with a rotary die cutter operating with a fixed diameter base. One cycle of the injector matches one complete cycle of the rotary die cutter. Figure 3 illustrates the main elements of the injector.

[0024] Guide rails 9 are fixed with respect to a stationary injector frame 24, which in turn is fixed with respect to the rotary die-cutting mechanism into which the web is proceeding with a reciprocating motion. A carriage 10 is mounted on the guide rails for reciprocating movement therealong, with respect to the injector frame 24.

[0025] First and second adjacent idler rollers 11 and 12 are mounted for free rotation on the injector frame 24, and specifically they are located at the rightward extremity thereof. A third idler roller 8 is also mounted for free rotation on the carriage 10, but is spaced leftwardly away from the two adjacent idler rollers 11 and 12, as can be seen clearly in the drawing.

[0026] A driven roller 13 as mounted for rotation about an axis which is fixed with respect to the injector frame, and is located with respect to the third idler roller 8 such that a web, when strung between the first and second idler roller 11 and 12, thence around the driven roller 13, thence around third idler roller 8, assumes a quasi-boustrophedonic configuration, such that a portion of the web can be taken up between the third idler roller 8 and the driven roller 13 when the carriage 10 moves in a direction which increases the distance between the third idler roller 8 and the driven roller 13 (i.e. moves to the right as pictured in the drawing). The length of web taken up is equal to the decrease in length of web simultaneously paid out from the injector mechanism. More specifically, looking at the drawing, if one imagines that the third idler roller 8 moves to the right while the driven roller 13 remains stationary, it will be seen that the web 3 will extend rightwardly to meet: the top periphery of the third idler roller 8, will encircle the third idler roller 8 half way, then will extend leftwardly to the top of the driven roller 13. If the two resulting reaches of the web are parallel, then a true boustrophedonic configuration would result. However, the aim of the present invention would be achieved, even if the two reaches of the web were not exactly parallel.

[0027] An upper endless belt 22 and a lower endless belt 23 are arranged to pass in juxtaposed relation between the first and second idler rollers 11 and 12, thence leftwardly toward the driven roller 13, thence around the driven roller 13, thence to and around the third idler roller 8, thence along different respective return paths to the first and second idler rollers 11 and 12. More particularly both the upper belt 22 and the lower belt 23 pass in juxtaposition from the top of the third idler roller 8 to the space between a fourth idler roller 20 and a fifth idler roller 21, the rollers 20 and 21 being juxtaposed at close spacing, but not providing a nip. Upon passing through the idler rollers 20 and 21, the upper and lower belts 22 and 23 separate and follow distinct paths back to the idler rollers 11 and 12, respectively.

[0028] More specifically, the upper belt 22 partly encircles the fourth idler roller 20, thence around two further idler rollers 18 and 17, from where it extends to contact the first idler roller 11.

[0029] The lower endless belt, upon exiting leftwardly between the fourth and fifth idler rollers 20 and 21, partly encircles the fifth idler roller 21, thence passes around further idler rollers 15 and 14, and finally to the second idler roller 12.

[0030] The idler rollers 17 and 18 are mounted on a web guide 19, which indepedently laterally locates the upper belt. Likewise, the idler rollers 14 and 15 are mounted on a web guide 16, which laterally locates the lower belt 23.

[0031] Thus, with the exception of the three rollers 8, 20 and 21 which are secured to the movable carriage 10, and with the exception of the driven roller 13, all of the rollers are idlers that are fixed in position with respect to the injector frame 24.

[0032] Translating motion in the carriage 10 is provided by a linear servo attached between the carriage 10 and the injector frame 24. Alternatively, the carriage can receive its translating motion from a servo-driven mechanical motion generator, which does not form part of the present invention. The roller 13 is preferably driven from a rotary servo motor located in the injector frame 24, this servo motor being always slaved to the motion of the printing section of the machine, thus following the line speed of the machine. Various registration controls can modify the servo drive to the roller 13, thus permitting die speed of the belts to be slowed relative to the main line (web) speed. This trimming action compensates for various anomalies in web properties,

such as tension variations caused from processing of the web in the print section of the machine.

[0033] The fourth and fifth idler rollers 20 and 21 are preferably geared together, which tends to promote synchronization of belt speeds. Alternatively, idler rollers 11 and 12 may be geared together.

[0034] It is preferred that the belts 22 and 23 be of relatively thin section, ideally in the region of about 31 thousandths of an inch. Also, it is preferred that the coefficient of friction of the belt surfaces in contact with the web be significantly lower than the coefficient of friction of the web surface.

[0035] In operation, recalling that the main function of the injector mechanism shown is to convert the movement of the web from continuous to modified motion, the web is drawn into the entry section between the stationary idler rollers 11 and 12 with constant motion, and the action of the belts 22 and 23 acting around the translating idlers 8, 20 and 21, results in the web exiting at a non-constant, but controlled speed relative to the frame 24. The carriage movement is controlled by the program driving the linear servo motor. This program can be readily altered to allow a wide range of web velocity profiles for the web exiting the injector. The translating action of the exit idlers 20 & 21 is such as to offer the exiting web into the rotary cutter with as small a bridging gap as possible. Web guidance means, such as a throat or rotating brushes can be used to support the exiting web as it makes its way between the translating idlers 20/21 and the nip point formed by the mating flexible plates 2.

[0036] Figures 4a to 4f show a web injection sequence in the machine beginning at the completion of the rotary die cutting cycle. Diagrams 4a through 4f depict the relationship between web, injector and rotary tool position at various points in the completion of one repeat cycle.

[0037] More particularly, let it be assumed that the base rollers rotate through four sequential generally equal arcs with each arc representing about one-quarter of the peripheral extent of the first portion of the die-cutting plates, i.e. the portion which engages the web. Motion generating means moves the carriage such that a) when the base rollers are at the position representing the beginning of the first arc, the die cutting plates have completed a previous operation and the trailing edges of said first portions of the die cutting plates coincide with the nip between the base rollers and also with a repeat length boundary of the web, b) while the base rollers rotate through the first arc the web decelerates to a standstill, c) while the base rollers rotate through the second arc the web accelerates in the reverse direction and retracts from between the base rollers, d) while the base rollers rotate through the third arc the web decelerates in the reverse direction and reaches a further standstill, e) while the base rollers rotate through the fourth arc the web resumes forward motion toward the base rollers, and f) when the base rollers are at the position representing the end of the fourth arc, the leading edge of the web coincides with and moves at synchronous speed with the leading edges of the first portions of the die cutting plates.

[0038] Figures 5a to 5c illustrate an embodiment of the invention utilizing an injector mechanism 6 as described in Figure 3, followed by a fixed diameter base rotary die cutter 30 as described in Figure 2, followed by an enveloping belt out feed device 7 as per patent 5,762,254, lastly followed by a state-of-the-art repeat diameter base rotary pin stripper and parts delivery section. Description of the operation of the pin stripper and delivery section can be found in U.S. Patent Application S.N. 08/946,577, filed on October 7, 1997, entitled "Method and Apparatus for Removing Waste Windows from Web Canon Material".

[0039] With this system, continuous web 3 from the print section of the machine enters the injector mechanism in which its continuous motion is convened into a variable motion such that the position of the printed images on the web 3 are synchronized with the cutting and creasing action of the fixed diameter base rotary die cutter 30. Upon exit from the rotary die cutter 30, the cut/creased web enters an enveloping belt outfeed assembly 7 in which the reciprocating motion of the web is converted back into constant velocity motion. Upon exiting outfeed assembly 7 with constant velocity, the web 3 then enters a repeat diameter base rotary pin stripper 31, the repeat of which is equal to the printed image repeat. Scrap parts 32 which are interior to each part are removed from the web by the stripper 31. The web 3 then passes through a set of driven delivery nips 35 and 36 which act to separate the carton parts 34 from the web matrix 33. Alternatively, the parts 34 may be retained in the web matrix 33 via a heavier nicking pattern and rewound unseparated into a roll 43 for subsequent processing.

[0040] The prime advantage of this embodiment is that the web 3 is kept in a tension-controlled state from the point of entry on the injector 6 to the point of parts delivery at delivery nips 35 and 36. This scheme allows for the greatest achievable print-to-die cut and pin stripping registration accuracy.

[0041] The tension level in the web in this section is programmed to vary through the length of the section in order to maintain control of the length of the web. This action facilitates print-to-die registration of the web.

[0042] Figures 6a and 6b illustrate a second embodiment of the invention utilizing an injector mechanism 6 as described in Figure 3, followed by a fixed diameter base rotary die cutter 30 as described in Figure 2, followed by a transition enveloping belt assembly 40, finally followed by a fixed diameter base rotary pin stripper 41.

[0043] With this system, continuous web 3 from the print section of the machine enters the injector mechanism in which its continuous motion is converted into a variable motion such that the position of the printed

images on the web 3 are synchronized with the cutting and creasing action of the fixed diameter base rotary die cutter 30. Upon exit from the rotary die cutter 30, the cut/creased web is in sheet (i.e. non-continuous) form and is immediately entrapped between the upper and lower belts of an enveloping belt assembly 40, the function of which is to assist with the transport of the sheeted web pieces to the fixed diameter base rotary pin stripper 41. The speed of the pin stripper matches that of die rotary die cutter, that is, they move in unison; however, they may or may not be operated in phase. In either case, the horizontal spacing between the rotary cutter 30 and the pin stripper 41 is adjustable, allowing the mechanism to accommodate different repeat lengths. For example, in the case where the rotary cutter 30 and the pin stripper 41 are run in-phase, the spacing between the units will be adjusted to permit the leading edge of each sheet to enter the nipping point of the stripper tool just as its trailing edge is leaving the nipping point of the rotary tool. As mentioned previously, the peripheral speed of the tools will be higher than the avenge speed of the web exiting the injector. The belts in the transition enveloping belt assembly 40 operate at the same speed as the peripheral speed of the rotary tools. The function of the fixed diameter pin stripper in this case is to remove internal scrap plus ladder matrix 32 such that parts 34 are delivered in finished form. The reason for using a fixed diameter base rotary stripper is the same as is the case for the rotary die cutter, that is, reduced tooling cost.

[0044] Figures 7a and 7b illustrate a third embodiment of the invention, in this case utilizing an injector mechanism 6 as described in Figure 3, followed by a fixed diameter base rotary die cutter 30 as described in Figure 2, followed by a decelerator enveloping belt assembly 42, finally followed by a repeat diameter base rotary pin stripper 31. In this embodiment, operation of the invention is the same as in the second embodiment shown in Figure 6, except for the use of a repeat diameter base rotary pin stripper 31. In this case, the peripheral speed of the pin stripper will match the speed of the web 3 entering the injector 6. As explained previously, the fixed base diameter rotary die cutter operates at a higher speed than the web 3 entering the injector. This being the case, it is necessary to decelerate and phase the sheeted pieces of the web exiting the rotary cutter so that they enter the repeat base diameter pin stripper 31 in register. The decelerator enveloping belt assembly 42 does this. The distance between the rotary die cutter 30 and the pin stripper 31 is adjustable in order to accommodate die cut sheets of various repeat lengths. Parts are separated from window and matrix scrap at the pin stripper 31.

[0045] While several embodiments of this invention have been illustrated in the accompanying drawings and described hereinabove, it will be evident to those skilled in the art that changes and modifications may be made therein without departing from the essence of this invention, as set forth in the appended claims.

Claims

1. For use with a machine through which an elongate web passes with continuous movement, the machine having means for performing a given operation on the web, said given operation lying within a predetermined repeat length, adjacent repeat lengths being separated by repeat length boundaries,
   the combination of:

   a rotary processing device including two rotary base rollers for positioning downstream of said machine, the rollers being juxtaposed to define a nip through which said web passes, each roller having the same circumference, said circumference exceeding the repeat length of said given operation, the rollers having secured thereto cooperating circumferential processing plates each of which includes a first portion intended to engage the web where rotary processing is carried out, and a second portion which does not engage the web; and drive means for rotating the base rollers;
   an injector mechanism adapted for positioning between said machine and said rotary processing device, said injector mechanism being adapted to modify the continuous movement of the web, as it comes from said machine, to a variable movement; the injector mechanism including:

   -- an injector frame,
   -- a carriage mounted on the frame for reciprocating movement with respect to said rotary processing device,
   -- first and second idler rollers mounted on the injector frame for free rotation,
   -- a third idler roller mounted on said carriage for free rotation, said third idler roller being spaced away from said first and second idler rollers,
   -- a driven roller mounted for rotation about an axis which is fixed with respect to the rotary processing device and is located with respect to the third idler roller such that the web, when strung between the first and second idler rollers, thence around said driven roller, thence around the third idler roller, assumes a quasibouscrophedonic configuration whereby the portion of the web between the third idler roller and the driven roller decreases when the carriage moves in a direction which decreases the distance between the third idler roller and the driven roller;

-- an upper and a lower endless belt passing in juxtaposed relation between said first and second idler rollers, thence around the driven roller, thence around said third idler roller, thence along different respective return paths to said first and second idler rollers;

-- drive means for positively rotating said driven roller at a substantially constant speed;

-- and motion generating means for moving the carriage with respect to said machine, such that the web has a variable motion required to juxtapose the leading edge of each repeat length on the web with the leading edges of said portions of the processing plates intended to engage the web.

2. The combination claimed in claim 1, in which, assuming rotation of the base rollers through four sequential generally equal arcs with each arc representing about one-quarter of the peripheral extent of said first portion of the rotary processing plates, said motion generating means moves the carriage such that: a) when the base rollers are at the position representing the beginning of the first arc, the rotary processing plates have completed a previous operation and the trailing edges of said first portions of the rotary processing plates coincide with the nip between the base rollers and also with a repeat length boundary of the web, b) while the base rollers rotate through the first arc the web decelerates to a standstill, c) while the base rollers rotate through the second arc the web accelerates in the reverse direction and retracts from between the base rollers, d) while the base rollers rotate through the third arc the web decelerates in the reverse direction and reaches a further standstill, e) while the base rollers rotate through the fourth arc the web resumes forward motion toward the base rollers, and f) when the base rollers are at the position representing the end of the fourth arc, the leading edge of the web coincides with and moves at synchronous speed with the leading edges of the first portions of the rotary processing plates.

3. The combination of claim 1 or 2, in which said given operation is a printing operation, and said processing plates are die-cutting and/or creasing plates.

4. The combination of claim 1, 2 or 3, further including an outfeed assembly positioned downstream of said base rollers, said outfeed assembly being adapted to modify the variable movement of the web, as it comes from the rotary processing device, back to continuous movement; wherein the outfeed assembly has a structure which is substantially the mirror image reverse of the injector structure.

5. The combination of claim 1, 2 or 3, further including an outfeed assembly positioned downstream of said base rollers, said outfeed assembly being adapted to modify the variable movement of the web, as it comes from the rotary processing device, back to continuous movement; the outfeed assembly including:

-- an outfeed carriage mounted for reciprocating movement with respect to said rotary processing device,

-- first and second outfeed idler rollers mounted for free rotation on said carriage,

-- a third outfeed idler roller mounted for free rotation on said carriage, said third outfeed idler roller being spaced away from said first and second outfeed idler rollers,

-- an outfeed driven roller mounted for rotation about an axis which is fixed with respect to the rotary processing device and is located with respect to the outfeed third idler roller such that the web, when strung between the first and second outfeed idler rollers thence around the third outfeed idler roller thence around said outfeed driven roller, assumes a quasi-boustrophedonic configuration whereby the portion of the web between the third outfeed idler roller and the outfeed driven roller decreases when the outfeed carriage moves in a direction which decreases the distance between the third outfeed idler roller and the outfeed driven roller;

-- an upper and a lower outfeed endless belt passing in juxtaposed relation between said first and second outfeed idler rollers, thence around said third outfeed idler roller, thence around the outfeed driven roller, thence along different respective outfeed return paths to said first and second outfeed idler rollers;

-- outfeed drive means for positively rotating said outfeed driven roller at a substantially constant speed;

-- and outfeed motion generating means for moving the outfeed carriage with respect to said rotary processing means, such that the web has returned to continuous movement upon exiting from the outfeed assembly.

6. The combination claimed in claim 5, in which a pin stripper means is provided downstream of the outfeed assembly, to receive the web and to remove waste windows therefrom.

7. A method for handling an elongate web proceeding at uniform speed from a process in which it repeatedly undergoes a given operation, said given operation lying within a predetermined repeat length,

adjacent repeat lengths being separated by repeat length boundaries,
the method including:

providing a rotary processing device including two rotary base rollers for positioning downstream of said process, the rollers being juxtaposed to define a nip through which said web can pass, each roller having the same circumference, said circumference exceeding the repeat length of said given operation, the rollers having secured thereto cooperating circumferential processing plates each of which includes a first portion intended to engage the web and a second portion which does not engage the web; and roller drive means for rotating the base rollers;
further providing an injector mechanism adapted for positioning upstream of said rotary processing device and for receiving said web, said injector mechanism being adapted to modify the continuous movement of the web, as it comes from said process, to a variable movement; the injector mechanism including:

--a frame,
-- a carriage mounted for reciprocating movement with respect to said rotary processing device,
-- first and second idler rollers mounted on the injector frame for free rotation,
-- a third idler roller mounted on said carriage for free rotation, said third idler roller being spaced away from said first and second idler rollers,
-- a driven roller mounted for rotation about an axis which is fixed with respect to the rotary processing device and is located with respect to the third idler roller such that the web, when strung between the first and second idler rollers, thence around said driven roller, thence around the third idler roller, assumes a quasiboustrophedonic configuration whereby the portion of the web between the third idler roller and the driven roller decreases when the carriage moves in a direction which decreases the distance between the third idler roller and the driven roller;
-- an upper and a lower endless belt passing in juxtaposed relation between said first and second idler rollers, thence around the driven roller, thence around said third idler roller, thence along different respective return paths to said first and second idler rollers;

the method further including:

-- rotating the base rollers of the rotary processing device;
-- rotating said driven roller at a substantially constant speed;
-- passing the web, after it emerges from said process, between the first and second idler rollers such that it is sandwiched between said upper and lower endless belts,
-- moving the carriage with respect to said machine such that the web has a variable motion required to juxtapose the leading edge of each repeat length on the web with the leading edges of said portions of the processing plates intended to engage the web.

8. The method claimed in claim 7, in which, assuming rotation of the base rollers through four sequential generally equal arcs with each arc representing about one-quarter of the peripheral extent of said first portion of the processing plates, the carriage is moved such that: a) when the base rollers are at the position representing the beginning of the first arc, the processing plates have completed a previous operation and the trailing edges of said first portions of the processing plates coincide with the nip between the base rollers and also with a repeat length boundary of the web, b) while the base rollers rotate through the first arc the web decelerates to a standstill, c) while the base rollers rotate through the second arc the web accelerates in the reverse direction and retracts from between the base rollers, d) while the base rollers rotate through the third arc the web decelerates in the reverse direction and reaches a further standstill, e) while the base rollers rotate through the fourth arc the web resumes forward motion toward the base rollers, and f) when the base rollers are at the position representing the end of the fourth arc, the leading edge of the web coincides with and moves at synchronous speed with the leading edges of the first portions of the processing plates.

9. The method of claim 7 or 8, in which said given operation is a printing operation.

10. The method of claim 7, 8 or 9, further including the step of providing an outfeed assembly positioned downstream of said base rollers, said outfeed assembly being adapted to modify the variable movement of the web, as it comes from the rotary processing device, back to continuous movement; wherein the outfeed assembly has a structure which is substantially the mirror image reverse of the injector structure.

11. The method of claim 7, 8 or 9, further including an outfeed assembly positioned downstream of said base rollers, said outfeed assembly being adapted

to modify the variable movement of the web, as it comes from the rotary processing device, back to continuous movement; the outfeed assembly including:

-- an outfeed carriage mounted for reciprocating movement with respect to said rotary processing device,
-- first and second outfeed idler rollers mounted for free rotation on said carriage.
-- a third outfeed idler roller mounted for free rotation on said carriage, said third outfeed idler roller being spaced away from said first and second outfeed idler rollers,
-- an outfeed driven roller mounted for rotation about an axis which is fixed with respect to the rotary processing device and is located with respect to the outfeed third idler roller such that the web, when strung between the first and second outfeed idler rollers, thence around the third outfeed idler roller, thence around said outfeed driven roller, assumes a quasi-boustrophedonic configuration whereby the portion of the web between the third outfeed idler roller and the outfeed driven roller decreases when the outfeed carriage moves in a direction which decreases the distance between the third outfeed idler roller and the outfeed driven roller;
-- an upper and a lower outfeed endless belt passing in juxtaposed relation between said first and second outfeed idler rollers, thence around said third outfeed idler roller, thence around the outfeed driven roller, thence along different respective outfeed return paths to said first and second outfeed idler rollers; the method further including:
-- passing the web between the outfeed endless belts and between the first and second outfeed idler rollers;
-- rotating said outfeed driven roller at a substantially constant speed;
-- and moving the outfeed carriage with respect to said rotary processing device such that the web has returned to continuous movement upon exiting from the outfeed assembly.

12. The method claimed in claim 11, further including the step of removing waste windows from the web downstream of the outfeed assembly.

13. The method of any one of claims 7 to 12, in which the base rollers of the rotary processing device are rotated at substantially constant speed.

14. The combination of any one of claims 1 to 6, in which the rotary processing device is a rotary creaser/cutter.

15. The method of any one of claims 7 to 13, in which the rotary processing device is a rotary creaser/cutter.

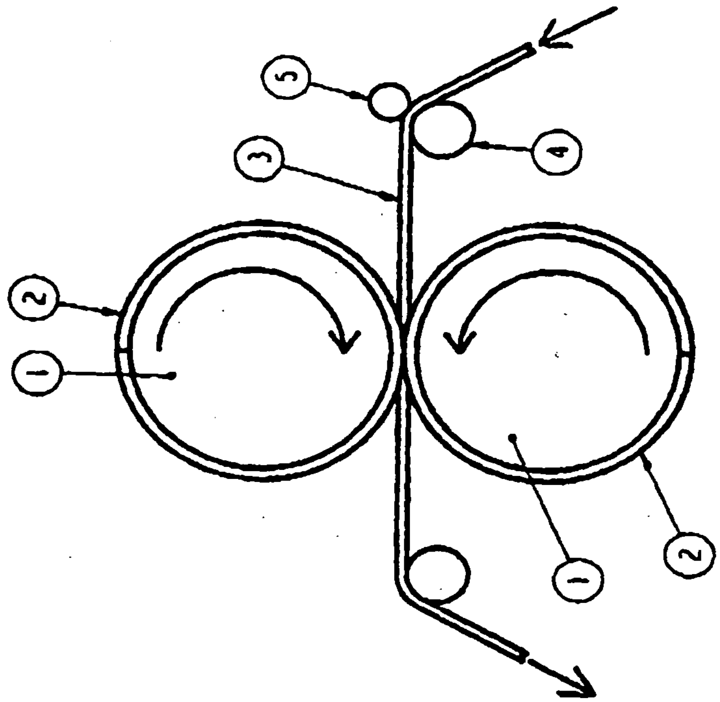


FIGURE 1B
PRIOR ART

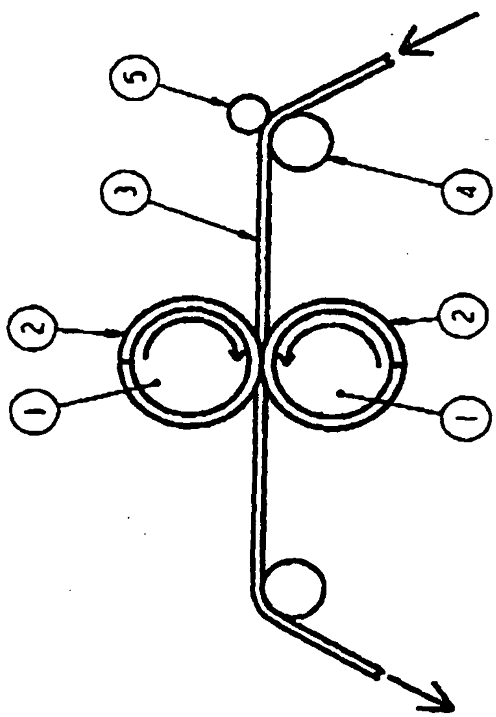
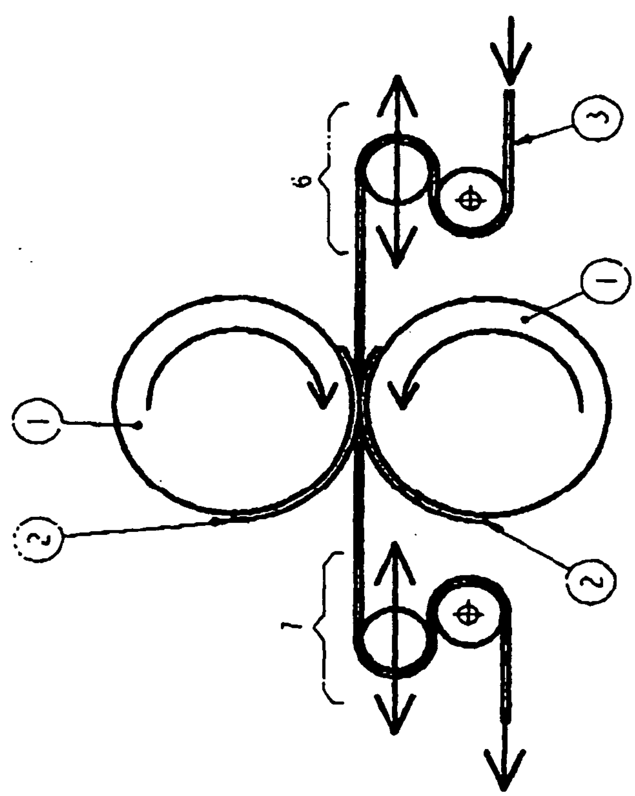


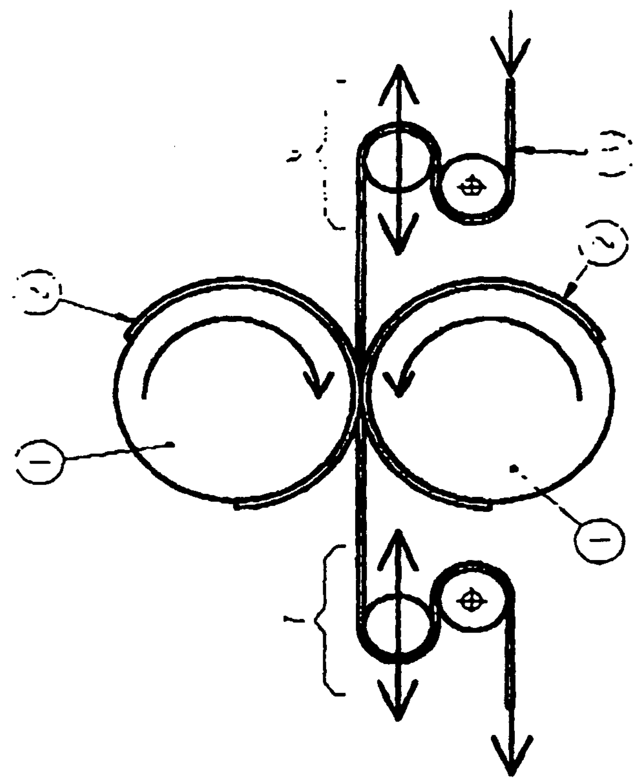
FIGURE 1A
PRIOR ART

FIXED DIAMETER BASE ROTARY DIE CUTTER
(BASE REPEAT "3X")



PRINT/DIE REPEAT "X"

FIGURE 2A



PRINT/DIE REPEAT "2X"

FIGURE 2B

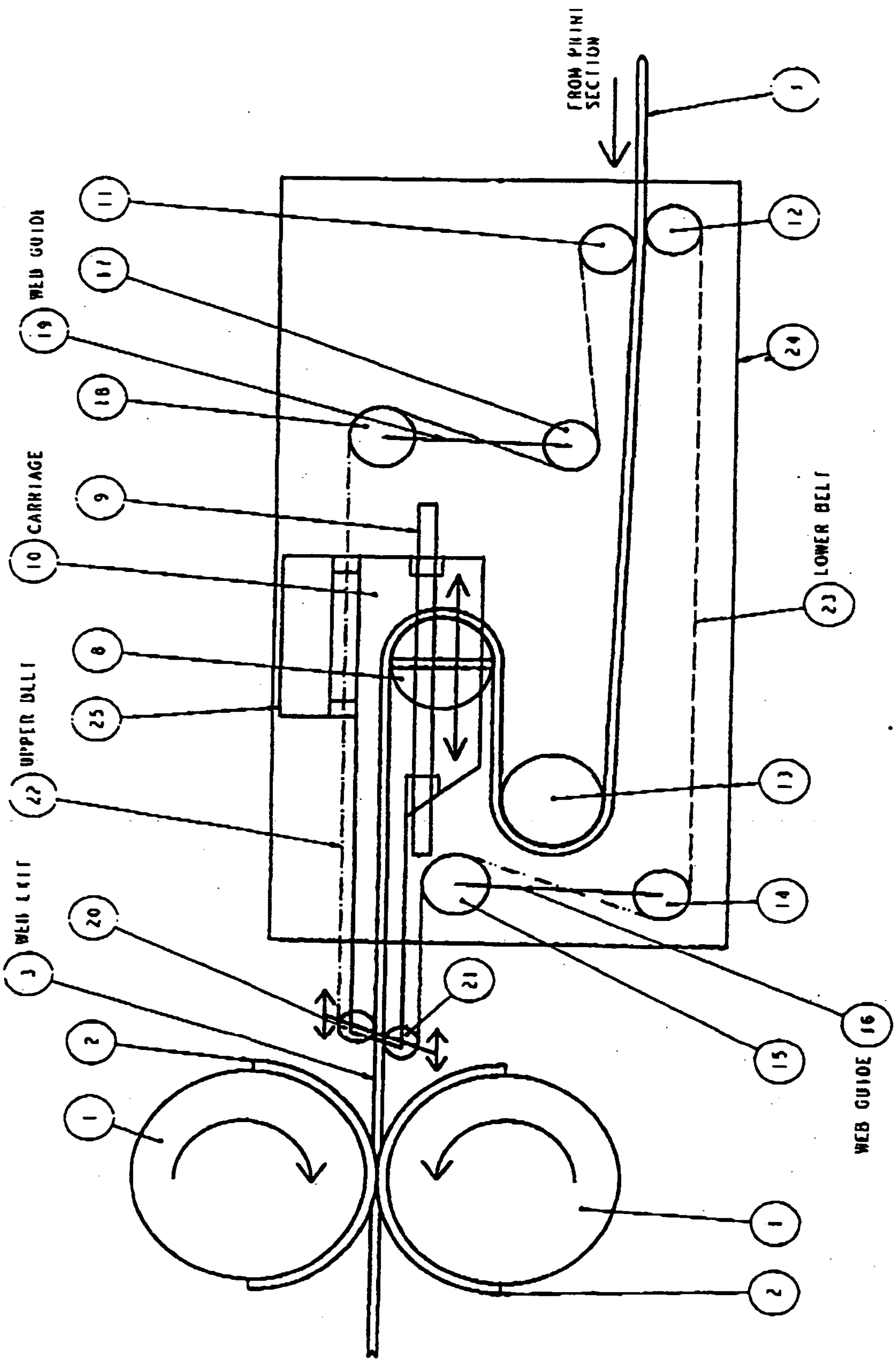

FROM PRINT SECTION
WEB GUIDE
CARRIAGE
UPPER BELT
WEB EXIT
LOWER BELT
WEB GUIDE

FIGURE 3

WEB IJECTION SEQUENCE

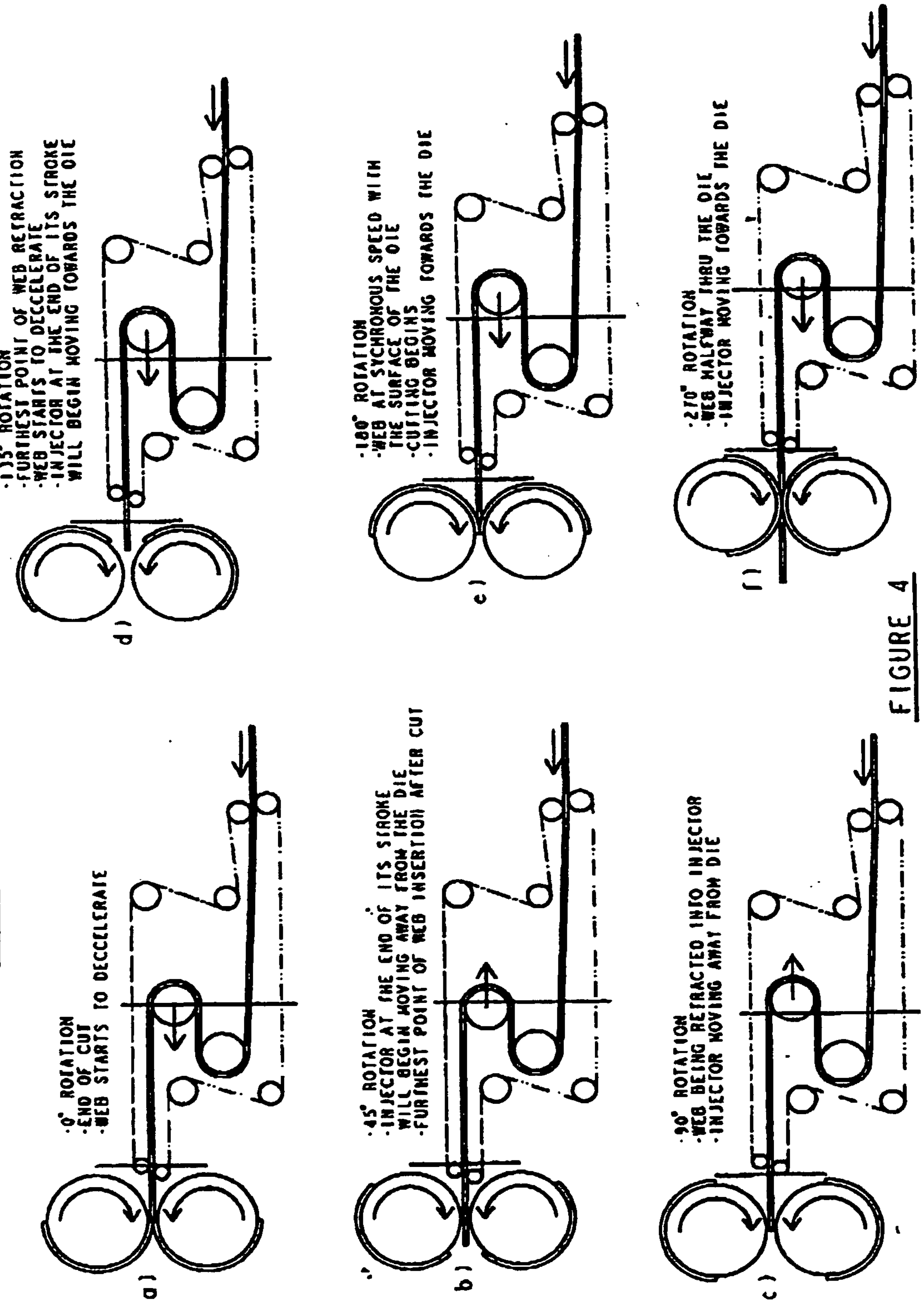


FIGURE 4

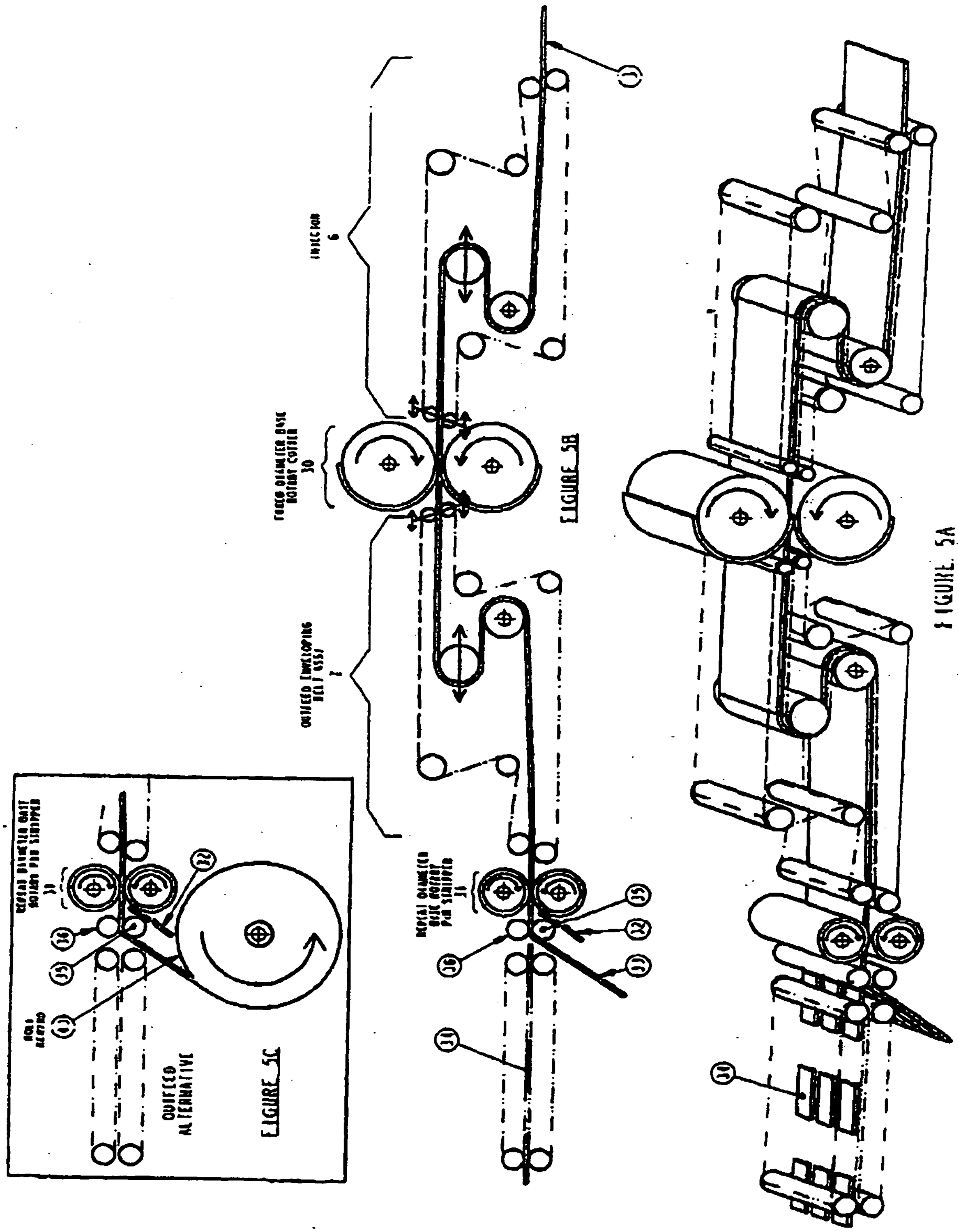


FIGURE 5B

FIGURE 5A

FIGURE 5C

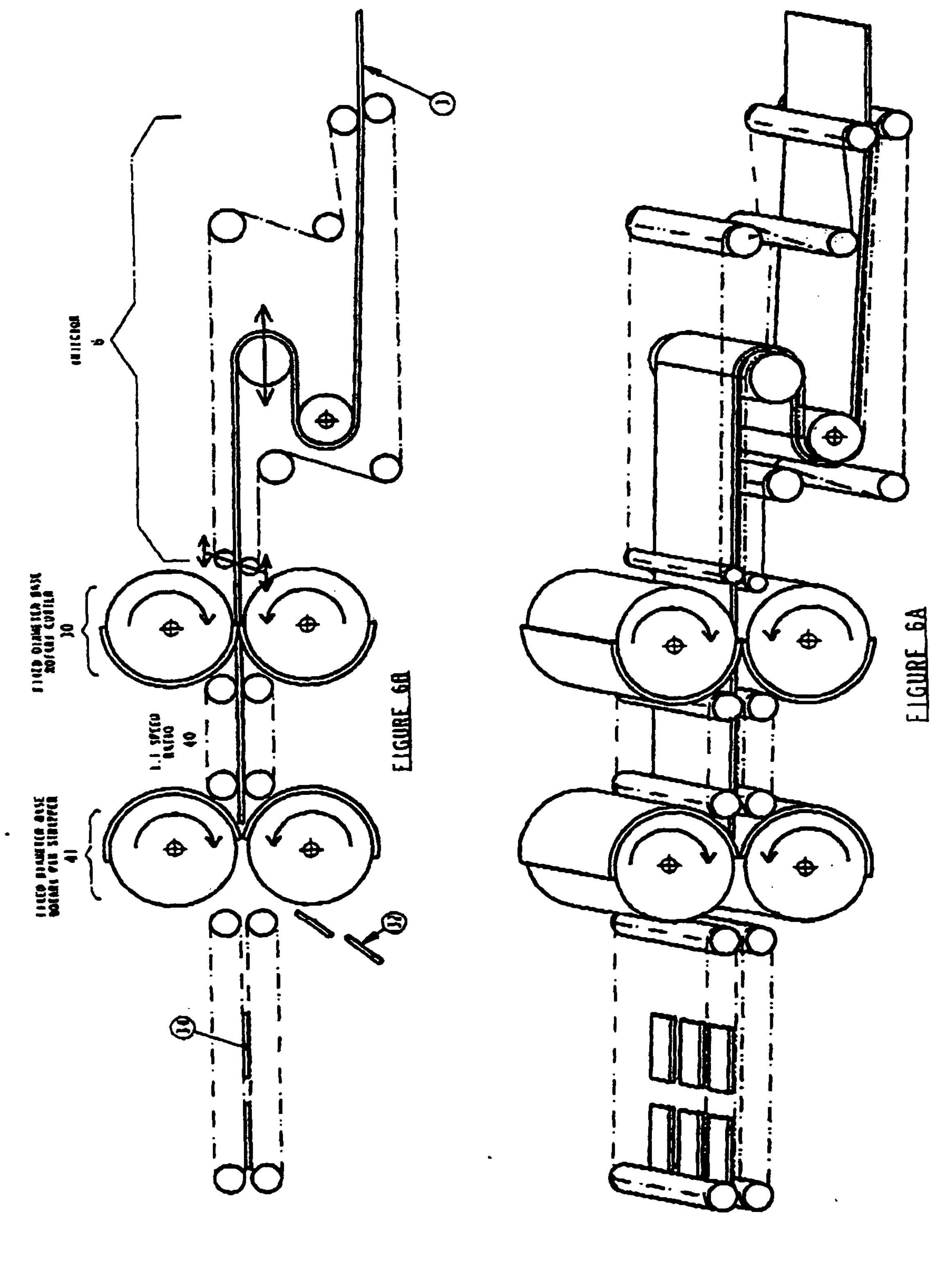


FIGURE 6A

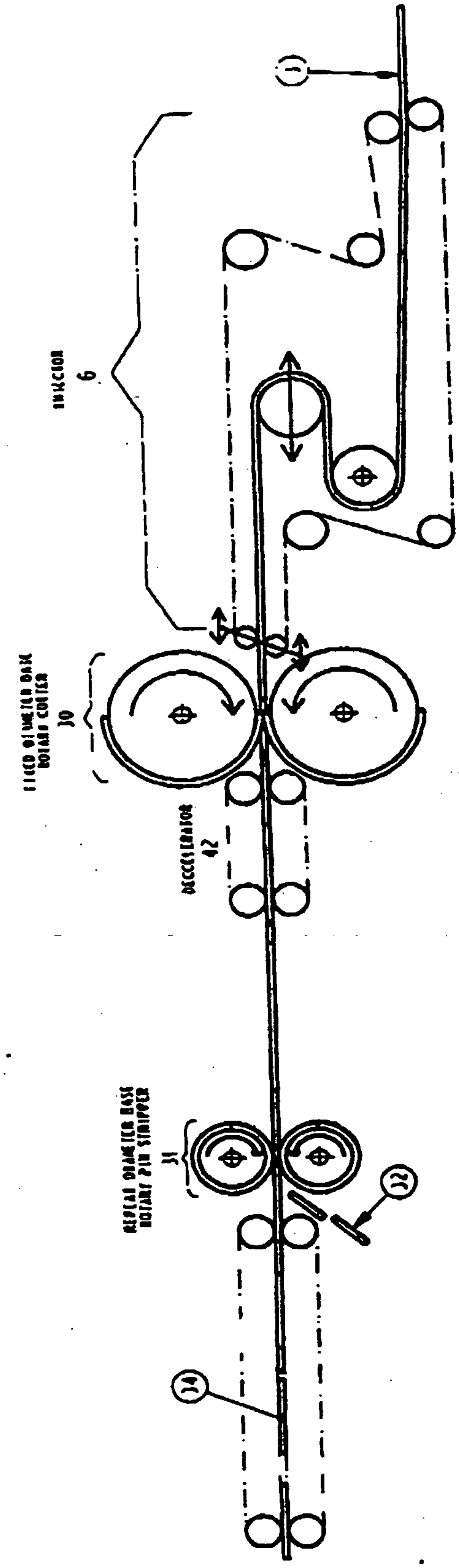


FIGURE 1B

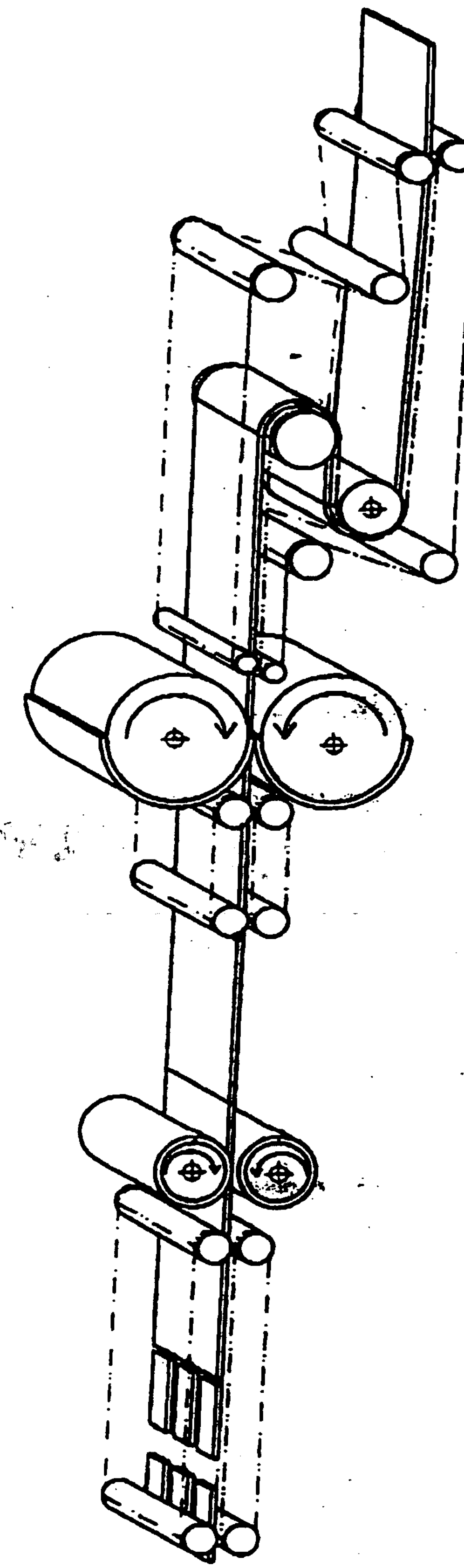


FIGURE 1A

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European Patent Office
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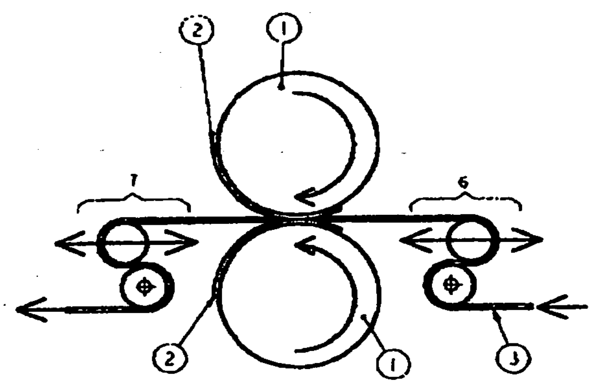
(54) **Injector for rotary web processing device with fixed diameter base**

(57) A unique rotary die cutting system including an injector mechanism (6) that accurately positions a moving continuous web (3) in such manner as to permit the implementation of a set of constant diameter cylindrical bases (1) onto which are mounted by various means a pair of removable complementary steel sheet dies (2). The integrated action of the novel sub-sections of the invention permits significant improvements in economies of operation relative to exiting rotary converting technologies.



PRINT/DIE REPEAT "X"

FIGURE 2A

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 0907

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 3 667 352 A (HELMIG RICHARD W ET AL) 6 June 1972 (1972-06-06) * column 2, line 12 - line 18 * * column 2, line 39 - line 53 * * column 4, line 45 - line 74 * * column 5, line 70 - column 6, line 22 * * column 6, line 72 - column 7, line 13 *	1,7	B65H23/04 B65H20/24
A	GB 1 058 883 A (GLOUCESTER ENGINEERING CO. LTD.) 15 February 1967 (1967-02-15) * page 1, left-hand column, line 12 - right-hand column, line 67 * * page 2, right-hand column, line 90 - page 3, left-hand column, line 20; figures *	1,7	
P,A	EP 0 915 049 A (SCA HYGIENE PROD AB) 12 May 1999 (1999-05-12) * column 11, line 45 - column 12, line 40; figure 1 *	1,7	
A	US 4 236 955 A (PRITTIE ALLAN R) 2 December 1980 (1980-12-02) * the whole document *	1,7	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B65H
D,A	US 5 762 254 A (CVERCKO MICHAL ET AL) 9 June 1998 (1998-06-09) * the whole document *	1,7	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 February 2001	Haaken, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 30 0907

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22-02-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3667352 A	06-06-1972	CA 925527 A	01-05-1973
		DE 2100630 A	28-10-1971
		GB 1296027 A	15-11-1972
		JP 52041516 B	19-10-1977
		SE 358341 B	30-07-1973
GB 1058883 A		NONE	
EP 0915049 A	12-05-1999	DE 19749593 A	20-05-1999
		JP 11208951 A	03-08-1999
US 4236955 A	02-12-1980	CA 1069380 A	08-01-1980
		DE 2748497 A	03-05-1978
		GB 1567243 A	14-05-1980
US 5762254 A	09-06-1998	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82